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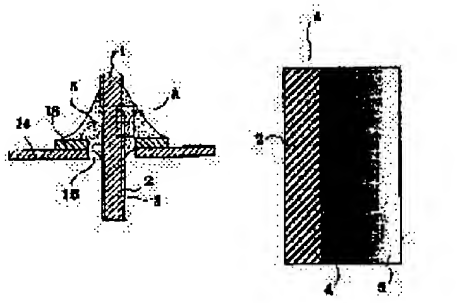
(54) SOLDERED WIRE

(57)Abstract:
PROBLEM TO BE SOLVED: To obtain soldered wire in which a thermal creep phenomenon is hard to be generated even in a high temp. environment, excellent in heat resisting strength, also free from the generation of whiskers and contg. no harmful lead by providing the outer circumference of a metallic elemental wire with a soldering layer having a compsn. in which specified amounts of silver and copper are incorporated into tin.
SOLUTION: Tin-silver-copper alloy soldered wire 1 is composed of metallic elemental wire 2 such as copper wire, copper alloy wire or the like and a hot dip soldering layer 3 composed of, by weight, 0.5 to 10.0% silver, 0.01 to 2.0% copper, and the balance tin formed on the outer circumference. In the case the soldered wire 1 is joined to a through hole 15 in a printed circuit board 14 by a brazing filler metal 5, the soldered wire 1 is soldered with a copper- applied layer 16 in the substrate 14. In the case, e.g. tin-lead alloy solder is used as the brazing filler metal 5, the plating layer 3 starts to melt, silver and tin therein respectively disperse and elute into the brazing filler metal 5 in the joined part A, and on the joined part A, a layer 4 increased in the contents of silver and tin and reduced in the content of lead deteriorating its heat resisting strength is thickly formed.



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ABSTRACT:

PROBLEM TO BE SOLVED: To obtain soldered wire in which a thermal creep phenomenon is hard to be generated even in a high temp. environment, excellent in heat resisting strength, also free from the generation of whiskers and contg. no harmful lead by providing the outer circumference of a metallic elemental wire with a soldering layer having a compsn. in which specified amounts of silver and copper are incorporated into tin.

SOLUTION: Tin-silver-copper alloy soldered wire 1 is composed of metallic elemental wire 2 such as copper wire, copper alloy wire or the like and a hot dip soldering layer 3 composed of, by weight, 0.5 to 10.0% silver, 0.01 to 2.0% copper, and the balance tin formed on the outer circumference. In the case the soldered wire 1 is joined to a through hole 15 in a printed circuit board 14 by a brazing filler metal 5, the soldered wire 1 is soldered with a copper-applied layer 16 in the substrate 14. In the case, e.g. tin-lead alloy solder is used as the brazing filler metal 5, the plating layer 3 starts to melt, silver and tin therein respectively disperse and elute into the brazing filler metal 5 in the joined part A, and on the joined part A, a layer 4 increased in the contents of silver and tin and reduced in the content of lead deteriorating its heat resisting strength is thickly formed.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention relates to the solder plating line which does not contain the lead component which has improved the heat-resistant intensity of the soldered-joint section especially about a solder plating line.
[0002]
[Description of the Prior Art] From the former, as a solder plating line, since what prepared the tin-lead-alloy solder plating layer in the periphery of a metal strand is excellent in solder plating workability or soldered-joint workability, generally it is widely used for the electrical machinery and apparatus or the electronic equipment member. However, recently, improvement in the heat-resistant intensity of the soldered-joint section comes to be called for with the miniaturization of an electrical machinery and apparatus or electronic equipment, and highly-efficient-izing from a viewpoint to which hot environments and the bird clapper of inside of a device increase, and it raises the reliability of the device under hot environments, and what is excellent in heat-resistant intensity also about a solder plating line is required. Moreover, the quantity by which an electrical machinery and apparatus and electronic equipment are disposed of as industrial waste also increases with rapid increase of production of an electrical machinery and apparatus or electronic equipment, the problem of the environmental pollution by a toxic substance vanishing from these devices by which the disposal was carried out is pointed out, and the solder plating line which does not contain a toxic substance has come to be called for.
[0003]
[Problem(s) to be Solved by the Invention] However, while the tin-lead-alloy solder plating line was equipped with many advantages on use, such as excelling in plating workability and soldered-joint workability, as mentioned above, when it is inferior to reliability in respect of the heat-resistant intensity of the soldered-joint section as a problem on a property and is especially used by hot environments, it tended to produce a thermal-creep phenomenon in the soldered-joint section of a tin-lead-alloy solder plating line and other members, and it had the big fault that a solder plating line fell out from the soldered-joint section. Furthermore, lead is eluted in an underground water by acid rain etc. as a problem on environment from the tin-lead-alloy solder plating line disposed of as industrial waste, environment is polluted, and the danger that this will be further taken in in a human body came to be pointed out. If lead is taken in inside of the body, it will cause the shape of a toxipathy, such as ischemia, abdomen gripes, acute encephalopathy, peripheral neuropathy, and nephropathy. Therefore, development of the solder plating line which does not contain lead detrimental to a human body had become pressing need.
[0004] As a plating line which does not contain detrimental lead, there is a tinning line which galvanized the tin metal simple substance, and it is widely used from heat-resistant intensity being comparatively high. However, there is a property in which a tin-whisker-like single crystal and a whisker occur from a tinning layer after plating processing in a tinning line, and, moreover, the inclination to grow up so long that plating thickness become thick again so that this whisker is put on elevated-temperature atmosphere was seen. For this reason, when a tinning line was used for the electronic equipment used as elevated-temperature atmosphere, there was a danger that generating of a whisker would cause short circuit accident owing to, and there was a problem in using it for the electronic equipment used as elevated-temperature atmosphere.
[0005] Then, the purpose of this invention is [that it is hard to produce a thermal-creep phenomenon under hot environments] excellent in heat-resistant intensity, and is to offer the solder plating line which does not contain the detrimental lead which does not generate a whisker.
[0006]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, the solder plating line of this invention is characterized [constitutional] by preparing the solder plating layer of the composition which silver becomes 0.5 to 10.0% of the weight, and the remainder becomes [copper] from tin and an unescapable impurity 0.01 to 2.0% of the weight in a metal strand periphery.
[0007]
[Function] Drawing 3 explains an operation of the tin-silver copper alloy-plating layer of the solder plating line of this invention, and an effect. Drawing 3 (a) is cross-section explanatory drawing showing the state where the solder plating line 1 of this invention was joined to the through hole 15 of a printed circuit board 14 by brazing filler metal 5, and the tin-silver copper alloy solder plating line 1 inserted in the through hole 15 is soldered by the copper-clad layer 16 and brazing filler metal 5 of a printed circuit board 14. Drawing 3 (b) is the expanded sectional view of the joint part A of the tin-silver copper alloy-plating layer 3 of the solder plating line 1, and brazing filler metal 5. For example, drawing 3 (b) explains the example at the time of using

tin-lead-alloy solder for brazing filler metal 5. In brazing-and-soldering process, the tin-silver copper alloy-plating layer 3 of the solder plating line 1 is ****, and While the silver in the plating layer 3 is spread into the brazing filler metal 5 of the joint part A, the tin in the plating layer 3 is eluted into the brazing filler metal 5 of the joint part A, the content of the silver which raises heat-resistant intensity, and tin increases to the joint part A, and the layer 4 in which the leaden content to which heat-resistant intensity is reduced decreased is formed. consequently, the joint A of the tin-silver copper alloy solder plating line 1 and brazing filler metal 5 -- silver and a tin component -- the layer which improved is formed thickly, and a heat-resistant creep property also improves Furthermore, if the tin-silver copper alloy brazing filler metal of the same composition as the plating layer 3 of the solder plating line 1 of this invention is used for brazing filler metal 5, the layer in which the lead component for which heat-resistant intensity is reduced does not contain the joint part A will be formed, and the rise creep property of heat-resistant intensity of the joint A of the tin-silver copper alloy solder plating line 1 and brazing filler metal 5 will also improve much more further.

[0008] Next, in the tin-silver copper alloy solder plating line 1 of invention, the reason which limited the content of the silver of the alloy solder plating layer 3 to 0.5% - 10.0% is because the melting point of alloy solder does not fall so much but it is inferior to hot-dipping nature, when the effect of the improvement in a heat-resistant creep property is not seen for a silver content at less than 0.5%. Moreover, when a silver content increases more than 10.0%, a heat-resistant creep property is because there is a fault to which the material cost of the plating line 1 becomes high, when the melting point of alloy solder becomes high too much and it is inferior to hot-dipping nature, although it improves. Moreover, a copper component is added in this alloy solder plating layer 3 for making hot-dipping work easy to lower the melting temperature of alloy solder and to carry out in order to raise plating appearance properties, such as gloss of the alloy solder plating line 1, and surface smoothness. the copper content of the reason which limits a copper content to 0.01% - 2.0% is because it is few and it is for the melting temperature of alloy solder not falling, either, a copper-tin alloy will precipitate during a hot-dipping bath if a copper content increases more than 2.0% again, and the effect of the improvement in a plating appearance property becomes the cause by which this adheres to the front face of the plating layer 3, and worsens plating appearance, at less than 0.01%

[0009] Moreover, since the plating layer 3 is formed with the tin-silver copper alloy, the solder plating line 1 of generating of the whisker looked at by the tin simple substance plating line of this invention is completely lost.

[0010] Moreover, since the solder plating line 1 of this invention does not contain lead in the plating layer 3, it does not do influence detrimental to a healthy side or an environmental side.

[0011]

[Example] Hereafter, this invention is explained based on an example. In addition, thereby, this invention is not limited. Drawing 1 is the cross section of the solder plating line 1 of this invention. It consists of a melting solder plating layer 3 of the composition which the silver which formed the solder plating line 1 in the periphery of the metal strands 2, such as copper wire or a copper alloy line, and the metal strand 2 becomes 0.5 to 10.0% of the weight, and the remainder becomes [copper] from tin and an unescapable impurity 0.01 to 2.0% of the weight.

[0012] Next, the manufacturing process view of drawing 2 is met and the manufacture embodiment of the solder plating line 1 of this invention is explained. The melting solder plating bath tub 6 has the inlet 11 of the metal strand 2 and the inert-gas inlet 10 which were prepared the plating liquid part containing melting solder plating liquid 7, and above the oil level of melting solder plating liquid 7, and the derivation mouth 12 of the solder plating line 1 formed in the oil-level perpendicular upper part of melting solder plating liquid 7, and has the composition that the whole oil-level upper part of melting solder plating liquid 7 was covered in the atmosphere layer of inert gas 8. In the melting solder plating bath tub 6 of this composition, the melting solder plating liquid 7 of the composition which consists of 3.5% of silver, 0.5% of copper, and remainder tin is held at 250 degrees of solution temperature C, and nitrogen gas is introduced as inert gas 8 from the inert gas inlet 10, and the whole oil-level upper part of melting solder plating liquid 7 is covered in a nitrogen gas atmosphere layer. Next, the run direction was converted by the block 13 within melting solder plating liquid 7, it pulled out from the oil level of melting solder plating liquid 7 to the perpendicular upper part, air cooling was derived and carried out [the annealed copper wire 2 with an outer diameter of 0.5mm was introduced into melting solder plating liquid 7 from the copper-wire inlet 11,] from the solder plating line derivation mouth 12, and the solder plating line 1 with 10 micrometers [in plating thickness] and a workmanship outer diameter of 0.52mm was obtained. In addition, in this melting solder plating bath tub 6, it can adjust to desired plating thickness only by controlling plating linear velocity, without using a workmanship dice by pulling out the solder plating line 1 from melting solder plating liquid 7 to the perpendicular upper part.

[0013] Although cross-section circle-like annealed copper wire was used for the metal strand 2 in the above-mentioned embodiment, the configuration of the metal strand 2 may be the annealed copper wire of the shape of the shape of a cross-section rectangle, and a cross-section square according to a use, and even if the quality of the material of the metal strand 2 is a copper alloy, of course, it is not what deviates from this invention in any way.

[0014] About the solder plating line 1 of this invention manufactured by the above, the result which performed the evaluation examination of a heat-resistant creep property and the whisker generating examination is described below.

[0015] - The solder plating copper wire 1 with 10 micrometers [in plating thickness] and a workmanship outer diameter of 10.52mm manufactured by the above-mentioned example mode was used for the example sample of a heat-resistant creep characteristic test-this invention. In addition, tin-lead-alloy solder plating copper wire with a workmanship outer diameter of 0.52mm which carried out hot dipping of the 63% alloy of 37%-tin of lead at 10 micrometers in plating thickness was used for annealed copper wire with an outer diameter of 0.5mm as a conventional example sample. As for the sample, the example sample and the conventional example sample prepared five respectively. After soldering Sample W to the through hole 15 with a bore

diameter [of the copper-clad printed circuit board 14] of 1mm and soldering each sample W to a printed circuit board 14 by through and 63% alloy brazing filler metal 17 of 37%-tin of lead so that a test method may be illustrated to drawing 4 , where a 1kg load is hung to the terminal of Sample W, it puts in in a thermostat with a temperature [C] of 130 degrees. And elapsed time after putting into a thermostat until Sample W falls out from the through hole 15 of a printed circuit board 14 was measured. It considered as evaluation of a heat-resistant creep property with this elapsed time. A test result is shown in Table 1. In addition, the measuring time of Table 1 is the average of five samples. It turns out that the tin-silver copper alloy solder plating line 1 of this invention is excellent in a heat-resistant creep property, and its heat-resistant intensity of the soldered-joint section is improving so that clearly from this result.

[0016]

表1 耐熱クリープ特性試験結果

耐熱クリープ特性	本発明実施例試料	従来例試料
試料が基板から抜け落ちるまでの経過時間	２７．３分	１３．９分

[0017] - The solder plating copper wire 1 with 10 micrometers [in the same plating thickness of structure] and a workmanship outer diameter of 0.52mm was used for the example sample of a whisker generating examination-this invention with having used for the above-mentioned heat-resistant creep characteristic test. Moreover, tinning copper wire with a workmanship outer diameter of 0.52mm which carried out hot dipping of the tin at 10 micrometers in plating thickness was used for copper wire with an outer diameter of 0.5mm as an example sample of comparison. As for the sample, the example sample and the example sample of comparison prepared five respectively. The whisker generating examination measured time after paying each sample to a thermostat with a temperature [C] of 50 degrees and putting into a thermostat until a whisker occurs in each sample. The generating check of a whisker was observed by one 2000 times the scale factor of this using the scanning electron microscope. A test result is shown in Table 2. In addition, the measuring time of Table 2 is the average of five samples.

[0018]

表2 ウイスカー発生試験結果

ウイスカー発生試験	本発明実施例試料	比較例試料
ウイスカーが発生するまでの経過時間	２０００時間経過後確認されず	６００時間経過時点にて発生

It was checked that generating of the whisker from which the tin-silver copper alloy solder plating line 1 of this invention causes short circuit accident is not seen at all so that clearly from the result of Table 2.

[0019]

[Effect of the Invention] The tin-silver copper alloy solder plating line of this invention does the following effects so, when it uses as path cords, such as electronic equipment. (1) Since it is hard coming to generate a thermal-creep phenomenon when the heat-resistant intensity in the soldering section improves and it is put on elevated-temperature atmosphere, the accident on which a solder plating line drops out of the soldering section is eliminated, and the reliability of the soldered-joint section improves. (2) Since there is no generating of a whisker, the danger of the short circuit accident which considered the whisker as the cause disappears. (3) Since the lead component detrimental to a human body is not contained, the safety of a healthy side and environmental side is secured.

[Translation done.]

* NOTICES *

1. This document has been translated by computer.So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] The solder plating line characterized by preparing the solder plating layer which silver becomes 0.5 to 10.0% of the weight, and the remainder becomes [copper] from tin and an unescapable impurity 0.01 to 2.0% of the weight in a metal strand periphery.

[Translation done.]

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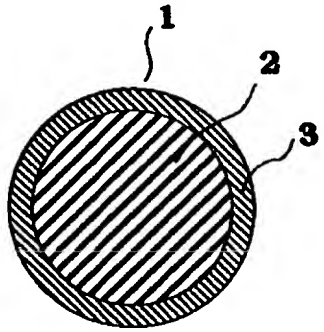
(54)【発明の名称】　はんだめっき線

(57)【要約】
【課題】　高温環境下においても熱的クリープ現象を生じ難くはんだ接続部における耐熱強度に優れ、めっき層からウイスカーが発生することのない、有害な鉛成分を含有しないはんだめっき線を提供する。
【解決手段】　銀が０．５～１０．０重量%、銅が０．０１～２．０重量%、残部が錫および不可避的不純物からなる組成のはんだめっき層３を金属素線２の外周に設けたはんだめっき線１。



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【特許請求の範囲】

【請求項1】　銀が0．5～10．0重量%、銅が0．01～2．0重量%、残部が錫および不可避的不純物からなるはんだめっき層を金属素線外周に設けたことを特徴とするはんだめっき線。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は、はんだめっき線に関するもので、特にはんだ接続部の耐熱強度を改善した鉛成分を含有しないはんだめっき線に関するものである。

【0002】

【従来の技術】従来から、はんだめっき線としては、金属素線の外周に錫一鉛合金はんだめっき層を設けたものが、はんだめっき作業性やはんだ接続作業性に優れることから電気機器や電子機器部材に一般に広く使用されている。しかし、近時、電気機器や電子機器の小型化、高性能化に伴い機器内が高温環境となることが多くなり、高温環境下における機器の信頼性を高める観点からはんだ接続部の耐熱強度の向上が求められるようになり、はんだめっき線についても耐熱強度の優れるものが要求されるようになっている。また、電気機器や電子機器の生産の急増に伴い、電気機器や電子機器が産業廃棄物として処分される数量も増大し、これら廃棄処分された機器から有害物質が散失することによる環境汚染の問題が指摘され、有害物質を含有しないはんだめっき線が求められるようにもなってきた。

【0003】

【発明が解決しようとする課題】ところが、錫一鉛合金はんだめっき線は、上述のように、めっき作業性、はんだ接続作業性に優れるなど使用上の利点を多く備えている反面、特性上の問題としてはんだ接続部の耐熱強度の点で信頼性に劣り、殊に高温環境で使用した場合に錫一鉛合金はんだめっき線と他の部材とのはんだ接続部において熱的クリープ現象を生じ易く、はんだめっき線がはんだ接続部から抜け落ちるという大きな欠点があった。また、更に環境上の問題として、産業廃棄物として処分された錫一鉛合金はんだめっき線から鉛が酸性雨等によって地下水中に溶出して環境を汚染し、更にはこれが人体内に摂取される危険性が指摘されるようになった。鉛は体内に摂取されると、貧血、腹部疝痛、急性脳症、末梢神経障害、腎障害といった中毒症状を引き起こす。従って、人体に有害な鉛を含有しないはんだめっき線の開発が急務となっていた。

【0004】有害な鉛を含有しないめっき線として、錫金属単体をめっきした錫めっき線があり、耐熱強度も比較的高いことから広く使用されている。しかし、錫めっき線にはめっき加工後に錫めっき層から錫の髭状単結晶、ウイスカーが発生するという性質があり、しかも、このウイスカーは高温雰囲気に置かれるほどまためっき厚さが厚くなるほど長く成長する傾向がみられた。この

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ため、錫めっき線を高温雰囲気となる電子機器に使用したとき、ウイスカーの発生が原因で短絡事故を引き起こす危険性があって、高温雰囲気となる電子機器に使用するには問題があった。

【0005】そこで本発明の目的は、高温環境下においても熱的クリープ現象を生じ難く耐熱強度に優れ、ウイスカーを発生することもない、有害な鉛を含有しないはんだめっき線を提供することにある。

【0006】

【課題を解決するための手段】上記目的を達成するため、本発明のはんだめっき線は、銀が0．5～10．0重量%、銅が0．01～2．0重量%、残部が錫および不可避的不純物からなる組成のはんだめっき層を金属素線外周に設けたことを構成上の特徴とするものである。

【0007】

【作用】本発明のはんだめっき線の錫一銀一銅合金めっき層の作用、効果を図3により説明する。図3（a）は、本発明のはんだめっき線1をプリント基板14のスルホール15へろう材5で接合した状態を示す断面説明図で、スルホール15へ挿入された錫一銀一銅合金はんだめっき線1はプリント基板14の銅張り層16とろう材5によりはんだ付けされる。図3（b）ははんだめっき線1の錫一銀一銅合金めっき層3とろう材5との接合部Aの拡大断面図である。例えば、ろう材5に錫一鉛合金はんだを用いた場合の例を図3（b）により説明する。ろう接過程ではんだめっき線1の錫一銀一銅合金めっき層3が融けだし、めっき層3中の銀が接合部Aのろう材5中へ拡散するとともにめっき層3中の錫が接合部Aのろう材5中へ溶出し、接合部Aには耐熱強度を向上させる銀と錫の含有量が増加し、耐熱強度を低下させる鉛の含有量の減少した層4が形成される。この結果、錫一銀一銅合金はんだめっき線1とろう材5との接合部Aは、銀と錫成分リッチの耐熱強度の向上した層が厚く形成され、耐熱クリープ特性も向上する。更に、ろう材5に本発明のはんだめっき線1のめっき層3と同じ組成の錫一銀一銅合金ろう材を用いれば、接合部Aは耐熱強度を低下させる鉛成分の含有されない層が形成され、錫一銀一銅合金はんだめっき線1とろう材5との接合部Aの耐熱強度は一層高まりクリープ特性も一段と向上することになる。

【0008】次に、発明の錫一銀一銅合金はんだめっき線1において、合金はんだめっき層3の銀の含有量を0．5%～10．0%に限定した理由は、銀の含有量が0．5%未満では耐熱クリープ特性向上の効果が見られない上、合金はんだの融点がさほど下がらず溶融めっき性に劣るためである。また、銀の含有量が10．0%より多くなると、耐熱クリープ特性は向上するものの合金はんだの融点が高くなりすぎて溶融めっき性に劣る上、めっき線1の材料コストが高くなる欠点があるためである。また、本合金はんだめっき層3に銅成分を添加する

のは、合金はんだめっき線１の光沢や表面滑らかさ等のめっき外観特性を向上させるためと合金はんだの溶融温度を下げ溶融めっき作業をし易くするためである。銅の含有量を０．０１％～２．０％に限定する理由は、銅の含有量が０．０１％未満ではめっき外観特性向上の効果が少なく、合金はんだの溶融温度も下がらないためであり、また銅の含有量が２．０％より多くなると溶融めっき浴中に銅－錫合金が沈澱してきて、これがめっき層３の表面に付着してめっき外観を悪化させる原因となるためである。

【０００９】また、本発明のはんだめっき線１は、めっき層３が錫－銀－銅合金で形成されているので、錫単体めっき線に見られるウイスカーの発生は全くなくなる。

【００１０】また、本発明のはんだめっき線１は、めっき層３に鉛を含有していないので、健康面や環境面に有害な影響を及ぼすことがない。

【００１１】

【実施例】以下、本発明を実施例に基づいて説明する。なお、これにより本発明が限定されるものではない。図１は、本発明のはんだめっき線１の断面図である。はんだめっき線１は、銅線或いは銅合金線等の金属素線２と、金属素線２の外周に形成した銀が０．５～１０．０重量％、銅が０．０１～２．０重量％、残部が錫および不可避的不純物からなる組成の溶融はんだめっき層３とからなる。

【００１２】次に、本発明のはんだめっき線１の製造実施態様を図２の製造工程図に沿って説明する。溶融はんだめっき浴槽６は、溶融はんだめっき液７の入っためっき液部と、溶融はんだめっき液７の液面より上部に設けた金属素線２の導入口１１と不活性ガス導入口１０と、溶融はんだめっき液７の液面垂直上方に設けたはんだめっき線１の導出口１２とを有し、溶融はんだめっき液７の液面上方全体が不活性ガス８の雰囲気層で覆われた構成となっている。かかる構成の溶融はんだめっき浴槽６内に、銀３．５％、銅０．５％、残部錫からなる組成の溶融はんだめっき液７を液温２５０°Ｃに保持し、また不活性ガス導入口１０から不活性ガス８として窒素ガスを導入し、溶融はんだめっき液７の液面上方全体を窒素ガス雰囲気層で覆う。次に、外径０．５mmの軟銅線２を銅線導入口１１より溶融はんだめっき液７中に導入＊し、溶融はんだめっき液７内にて滑車１３で走行方向を転換し溶融はんだめっき液７の液面から垂直上方へと引き出し、はんだめっき線導出口１２から導出、大気冷却して、めっき厚さ１０μm、仕上り外径０．５２mmのはんだめっき線１を得た。なお、この溶融はんだめっき浴槽６では、はんだめっき線１を溶融はんだめっき液７から垂直上方へ引き出すことにより、仕上りダイスを用いることなく、めっき線速を制御するだけで所望のめっき厚さに調整することができる。

【００１３】上記実施態様では、金属素線２に断面円状の軟銅線を用いたが、金属素線２の形状は、用途に応じ断面長方形状或いは断面正方形状の軟銅線であってよく、また金属素線２の材質は銅合金であっても、何ら本発明を逸脱するものでないことは勿論である。

【００１４】上記により製造した本発明のはんだめっき線１について、耐熱クリープ特性の評価試験およびウイスカー発生試験を行った結果を以下に記す。

【００１５】－耐熱クリープ特性試験－

本発明の実施例試料には、上記の実施例態様により製造しためっき厚さ１０μm、仕上り外径１０．５２mmのはんだめっき銅線１を用いた。なお、従来例試料として、外径０．５mmの軟銅線に鉛３７％－錫６３％合金をめっき厚さ１０μmに溶融めっきした仕上り外径０．５２mmの錫－鉛合金はんだめっき銅線を用いた。試料は実施例試料、従来例試料とも各５本を用意した。試験方法は、図４に図示するように、銅張りプリント基板１４の穴径１mmのスルホール１５に試料Wを通し、鉛３７％－錫６３％合金ろう材１７にて各試料Wをプリント基板１４にはんだ付けした後、試料Wの端末に１ｋｇの荷重を吊るした状態で温度１３０°Ｃの恒温槽内に入れる。そして、恒温槽に入れてから試料Wがプリント基板１４のスルホール１５から抜け落ちるまでの経過時間を測定した。この経過時間をもって耐熱クリープ特性の評価とした。試験結果を表１に示す。なお、表１の測定時間は試料５本の平均値である。この結果から明らかなように、本発明の錫－銀－銅合金はんだめっき線１は、耐熱クリープ特性に優れ、はんだ接続部の耐熱強度が向上していることが分かる。

【００１６】

表１　耐熱クリープ特性試験結果

耐熱クリープ特性	本発明実施例試料	従来例試料
試料が基板から抜け落ちるまでの経過時間	２７．３分	１３．９分

【００１７】－ウイスカー発生試験－

本発明の実施例試料には、上記耐熱クリープ特性試験に用いたと同じ構造のめっき厚さ１０μm、仕上り外径※０．５２mmのはんだめっき銅線１を用いた。また、比較例試料として、外径０．５mmの銅線に錫をめっき厚さ１０μmに溶融めっきした仕上り外径０．５２mmの

5　　6

錫めっき銅線を用いた。試料は実施例試料、比較例試料とも各5本を用意した。ウイスカー発生試験は、各試料を温度50°Cの恒温槽に入れ、恒温槽に入れてから各試料にウイスカーが発生するまでの時間を測定した。ウイスカーの発生確認は、走査型電子顕微鏡を用い倍率2000倍にて観察した。試験結果を表2に示す。なお、表2の測定時間は試料5本の平均値である。

【0018】

表2　ウイスカー発生試験結果

ウイスカー発生試験	本発明実施例試料	比較例試料
ウイスカーが発生するまでの経過時間	2000時間経過後確認されず	600時間経過時点にて発生

表2の結果から明らかなように、本発明の錫一銀一銅合金はんだめっき線1は短絡事故の原因となるウイスカーの発生が全く見られないことが確認された。

【0019】

【発明の効果】本発明の錫一銀一銅合金はんだめっき線は、電子機器等の接続線として用いたとき次のような効果を奏する。(1) はんだ付け部における耐熱強度が向上し、高温雰囲気に置かれた場合にも熱的クリープ現象を生じ難くなるので、はんだめっき線がはんだ付け部から脱落する事故がなくなり、はんだ接続部の信頼性が向上する。(2) ウイスカーの発生がないので、ウイスカーを原因とした短絡事故の危険性がなくなる。(3) 人体に有害な鉛成分を含有していないので、健康面、環境面の安全性が確保される。

【図面の簡単な説明】

【図1】本発明のはんだめっき線の1実施例を示す断面図である。

【図2】本発明のはんだめっき線の製造工程の1実施例を示す説明図である。

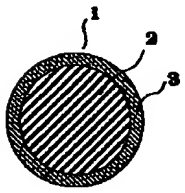
【図3】本発明のはんだめっき線をプリント基板へろう接した状態の説明図である。同図(a) は接合状態を示す※断面説明図であり、同図(b) は接合部の部分拡大断面説明図である。

【図4】耐熱クリープ特性試験の試験方法を示す説明図である。

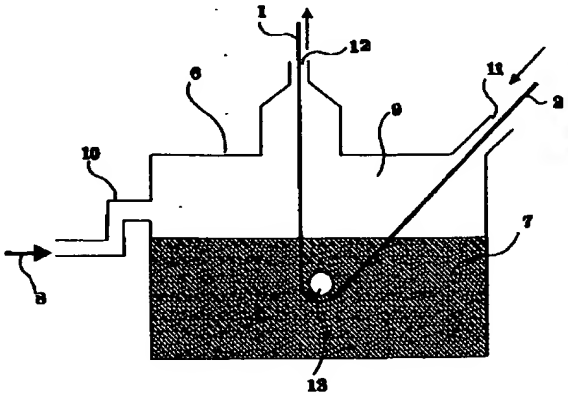
【符号の説明】

1　錫一銀一銅合金はんだめっき線
2　金属素線
3　錫一銀一銅合金めっき層
4　錫、銀拡散層
5　ろう材
6　はんだめっき浴槽
7　はんだめっき液
8　不活性ガス
9　不活性ガス雰囲気層
10　不活性ガス導管
11　金属素線導入口
12　はんだめっき線導出口
13　滑車
14　プリント基板
15　スルホール
16　銅張り層

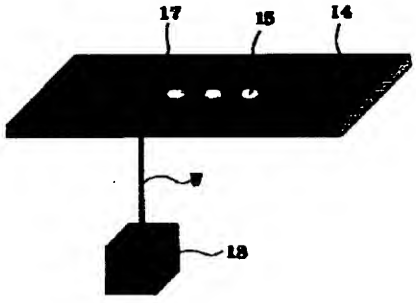
【図1】



【図2】



【図4】



【図3】